

## ACCELERATED BIODEGRADATION OF ORGANIC CONTAMINANTS BY HUMIC ACID

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### RESEARCH OBJECTIVES

The role of humic acid (HA) in the biodegradation of toxic polycyclic aromatic hydrocarbons (PAHs) has been the subject of controversy in the design of bioremediation strategy for polluted sites, particularly in unsaturated environments. To solve this controversy, we utilized our novel synchrotron infrared (SIR) spectromicroscopy technique to monitor, *in situ* and over time, the influence of HA on the degradation of pyrene (a model PAH) by a bacterial colony on a magnetite surface.

### APPROACH AND ACCOMPLISHMENTS

The pyrene-degrading bacterium used for this study is *Mycobacterium* sp. JLS, a gram-positive, rod-shaped bacterium recently isolated from PAH-contaminated soil at the Libby

Groundwater Superfund Site in Libby, Montana. We took time-course “snap shots” of actions of *M. sp. JLS* at the same location on each pyrene-coated sample over more than a month. For comparison, we conducted similar experiments in the absence of either Elliott Soil Humic Acid (ESHA) or bacteria (i.e., abiotic experiments). We summarize in Figure 1 the time-course of pyrene degradation under different experimental conditions over more than a month. We found that, with only slow removal mechanisms, pyrene remains on the mineral surface. For samples occupied by *M. sp. JLS*, ESHA dramatically shortens the onset time for pyrene biodegradation from 168 to 2 hours. Further analysis of spectral fingerprints showed that in the absence of ESHA, it takes the bacteria about 168 hours to produce sufficient glycolipids to solubilize pyrene and make it available for biodegradation. It is likely that the increased bioavailability of pyrene by HA accelerates bacteria-induced degradation.

### SIGNIFICANCE OF FINDINGS

This is the first study that provides direct evidence that HA can accelerate PAH biodegradation through the mechanism of enhanced bioavailability, which will have significant implications for bioremediation of contaminated soils. We can obtain this type of important biogeochemical information because of our novel and powerful SIR spectromicroscopy technique. This technique enabled research to assess, in real time, the interactions between multiple constituents in contaminated soils.

### RELATED PUBLICATION

Holman, H.-Y. N., K. Nieman, D.L. Sorensen, C.D. Miller, M.C. Martin, T. Borch, W.R. McKinney, and R.C. Sims, Catalysis of PAH biodegradation by humic acid shown in synchrotron infrared studies. *Environmental Science & Technology*, 36(6), 1276–1280, 2002.

### ACKNOWLEDGMENTS

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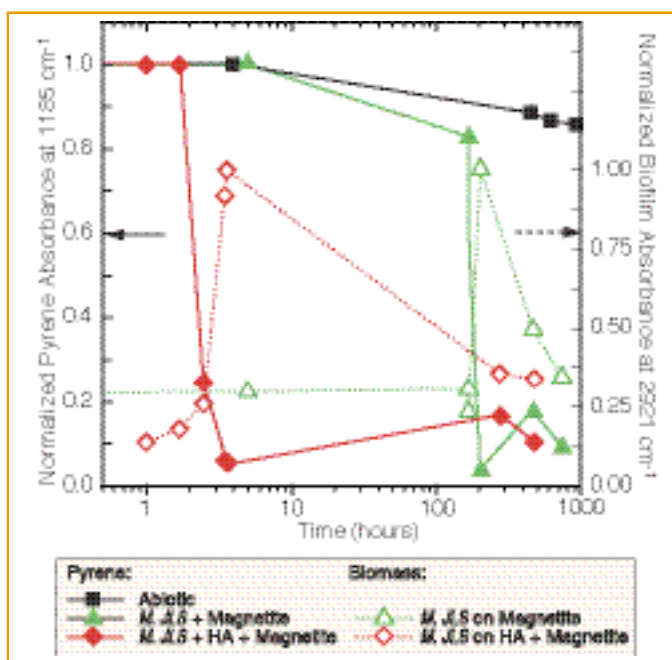


Figure 1. Summary of IR results showing that pyrene degradation occurs much faster when HA is present (note the log scale on the time axis). The color scheme is black for abiotic, green for biotic without HA, and red for biotic with HA. The solid lines show the pyrene amount (left axis) as a function of time for each experiment. The dotted lines show a subsequent increase in *Mycobacterium* sp. JLS biomass (right axis) after pyrene degradation.